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EXAMINER	
GROSS, KENNETH A	

ART UNIT	PAPER NUMBER
2122	16

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/560,555	STEPHENSON ET AL.	
	Examiner	Art Unit	
	Kenneth A Gross	2122	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *06 November 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

13)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

a) ☐ The translation of the foreign language provisional application has been received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

1. This action is in response to the amendment filed November 6th, 2003.

2. The 35 U.S.C. 103(a) rejections of Claims 1, 6, 9, and 14 have been withdrawn. A new 35 U.S.C. 103(a) rejection has been provided in this action for these Claims.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claim 1, 6, 9, and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Buzbee et al. (U.S. Patent Number 5,815,720) in view of Heisch et al. (U.S. Patent Number 5,613,118) and further in view of Buzbee et al. (U.S. Patent Number 6,275,981) and Goebel (U.S. Patent Number 6,139,200).

In regard to Claim 1, Buzbee (U.S. Patent Number 5,815,720) teaches: (1) accessing the first intermediate representation of source code with instrumented instructions (Column 2, lines 20-25); (2) Annotating intermediate code with data as shown in Figure 5, element 42; (3) Updating the data using a propagation scheme. This is shown in Figure 5, elements 44-45, where a translator generates profile information based on annotations; (4) Optimizing intermediate code using the data. "Profile information 36 is used during a second compile to produce an optimized application 38. (Column 3, lines 55-56, figure 6); (5) Repeating steps (3) and (4) at least once. The "process my be repeated to generate additional profile information about the optimized

object code to further optimize object code for the application." (Column 2, lines 16-18). Buzbee (U.S. Patent Number 5,815,720) does not specifically teach that the instrumented instructions are placed in the source code of the intermediate representation of the computer program. Heisch, however, does teach instrumenting source code with instructions for the purposes of data generation (Column 6, lines 14-16). Neither Buzbee (U.S. Patent Number 5,815,720) nor Heisch teach specifically teach that the data annotated into the intermediate representation is frequency data. Buzbee (U.S. Patent Number 6,275,981), however, does teach annotating source code with frequency data (Column 1, lines 43-52 and Column 2, lines 6-20). Buzbee (U.S. Patent Number 5,815,720) teaches performing multiple optimizations, but neither Buzbee (U.S. Patent Number 5,815,720), nor Heisch, nor Buzbee (U.S. Patent Number 6,275,981) teach performing multiple updates and optimizations during the same compilation pass. Goebel, however, does teach performing multiple feedback data updates and optimization in a single compiler pass (Figure 5, items 540 and 570 and Column 8, lines 30-35). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to access an instrumented intermediate code, annotate it with data, and update the data and perform optimizations of the source code multiple times, as taught by Buzbee (U.S. Patent Number 5,815,720), where instrumentation instructions are placed in the source code, as taught by Heish, since this allows a programmer to adjust instrumentation at the more-understandable source level, and the feedback data is frequency data as taught by Buzbee (U.S. Patent Number 6,275,981), and the multiple updates and optimizations occur in one compiler pass, as taught by Goebel, since this allows for a fully optimized program on only one compilation.

Claim 6 is a product claim that corresponds with Claim 1 and are rejected for the same reasons as Claim 1, where Buzbee (U.S. Patent Number 5,815,720) teaches a product for carrying out said method (Column 10, lines 1-10).

Claims 9 and 14 contain limitations that have already been addressed in the rejection of Claim 1, and Claims 9 and 14 are rejected for the same reasons as Claim 1.

5. Claims 2, 10, and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Buzbee et al. (U.S. Patent Number 5,815,720) in view of Heisch et al. (U.S. Patent Number 5,613,118) and further in view of Buzbee et al. (U.S. Patent Number 6,275,981), Goebel (U.S. Patent Number 6,139,200), and Chaitin (U.S. Patent No. 4,656,582).

In regard to Claim 2, Buzbee (U.S. Patent Number 5,815,720), Heisch, Buzbee (U.S. Patent Number 6,275,981), and Goebel (U.S. Patent Number 6,139,200) teach the method of Claim 1, but do not teach that dead code elimination, dead store elimination, branch elimination, or code transformation optimizations are preformed. However, the Chaitin reference teaches a method of optimizing compiled code using dead code elimination. (Column 9, line 40) Chaitin calls dead code elimination a "standard technique." Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to perform the method of Claim 1, where dead code elimination is preformed, as taught by Chaitin, since it is a standard and beneficial technique for optimization.

Claims 10 and 15 contain limitations that have already been addressed in Claim 2 and are rejected for the same reasons as Claim 2.

6. Claims 3, 7, 11, and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Buzbee et al. (U.S. Patent Number 5,815,720) in view of Heisch et al. (U.S. Patent Number

5,613,118) and further in view of Buzbee et al. (U.S. Patent Number 6,275,981), Goebel (U.S. Patent Number 6,139,200), and Robert Morgan, "Building an Optimizing Compiler" (hereinafter Morgan).

In regard to Claim 3, Buzbee (U.S. Patent Number 5,815,720), Heisch, Buzbee (U.S. Patent Number 6,275,981), and Goebel (U.S. Patent Number 6,139,200) teach the method of Claim 1, but do not teach that the second source code (or intermediate representation) should be represented a tree corresponding to procedures within the source code. However, Morgan teaches in Chapter 4, Section 1 (page 94) that "Optimizing compilers use a range of different data structures to represent procedures being compiled...the procedure may be represented as a tree...it is natural to represent the procedure as a tree." See abstract syntax trees in Section 4.1 for representing procedures. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention perform the method of Claim 1, wherein the intermediate representation of the source code would be a tree structure, as taught by Morgan, since a tree representation allows for easier access to parsed data.

Claim 7 is a product claim that corresponds with Claim 3 and are rejected for the same reasons as Claim 3, where Buzbee (U.S. Patent Number 5,815,720) teaches a product for carrying out said method (Column 10, lines 1-10).

Claims 11 and 16 contain limitations that have already been addressed in the rejection of Claim 3, and Claims 11 and 16 is rejected for the same reasons as Claim 3.

7. Claims 4, 5, 8, 12, and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Buzbee et al. (U.S. Patent Number 5,815,720) in view of Heisch et al. (U.S. Patent Number 5,613,118), and further in view of Buzbee et al. (U.S. Patent Number 6,275,981), Goebel (U.S.

Patent Number 6,139,200), Robert Morgan, "Building an Optimizing Compiler" (hereinafter Morgan), and Larus (U.S. Patent Number 6,327,699).

In regard to Claim 4, Buzbee et al. (U.S. Patent Number 5,815,720), Heisch, Buzbee et al. (U.S. Patent Number 6,275,981), Goebel, and Morgan teach the method of Claim 3, but do not teach the conversion from a tree to a control flow graph and the annotation of frequency values to said control graph as described by applicant in Claim 4. However, the Larus reference does teach the conversion of a program into a control flow graph, which profiles the entire path of a program. Larus describes a method that instruments a program with code and then executes the program in order to trace the entire path of the program. Furthermore, Larus teaches that the control flow graph would collect metrics as it profiles the program path, one such metric being the frequency of the execution of a program path. (Claims 1, 6, 7 of Larus) Since it is beneficial to represent source code as a tree, it would have been apparent to convert a tree into a control flow diagram, deriving the benefits from the tree representation. Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to perform the method of Claim 3, wherein the method further includes the steps of converting the tree into a control flow graph as taught by Larus and then run a plurality of sample executions on the code, collecting frequency information as taught by Larus, since this is a more beneficial method for collecting frequency information.

Claim 8 is a product claim that corresponds with Claim 4 and are rejected for the same reasons as Claim 4, where Buzbee (U.S. Patent Number 5,815,720) teaches a product for carrying out said method (Column 10, lines 1-10).

In regard to Claim 5, Buzbee (U.S. Patent Number 5,815,720) teaches that his translator generates profile information by "associating counters with the branches (arc counting)" or with "code representing each line." (Column 7, lines 1-3) These counter values, being precise measurements, can be classified as EXACT values. Therefore, it is obvious to one with ordinary skill in the art at the time of the invention to use a source code optimizing compiler described by Buzbee with a tree representation of the intermediate code. It is further obvious to construct a flow graph from this tree, giving counter values to the arcs of said flow graph, and labeling these counter values as EXACT, since they represent the exact number of times certain portions of code have been executed.

Claims 12 and 13 contain limitations that have already been addressed in the rejections of Claims 4 and 5, and Claims 12 and 13 are rejected for the same reasons as Claims 4 and 5, respectively.

8. Claims 17 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Buzbee et al. (U.S. Patent Number 5,815,720) in view of Heisch et al. (U.S. Patent Number 5,613,118), and further in view of Buzbee et al. (U.S. Patent Number 6,275,981), Goebel (U.S. Patent Number 6,139,200), and Larus (U.S. Patent Number 6,327,699).

Claims 17 and 18 contain limitations that have already been addressed in the rejections of Claims 4 and 5, and Claims 17 and 18 are rejected for the same reasons as Claims 4 and 5, respectively.

9. Claims 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Buzbee et al. (U.S. Patent Number 5,815,720) in view of Heisch et al. (U.S. Patent Number 5,613,118), and further in view of Buzbee et al. (U.S. Patent Number 6,275,981), Goebel (U.S. Patent Number

6,139,200), Larus (U.S. Patent Number 6,327,699), and Dean et al. (U.S. Patent Number 6,070,009).

In regard to Claim 19, Buzbee et al. (U.S. Patent Number 5,815,720), Heisch, Buzbee et al. (U.S. Patent Number 6,275,981), Goebel, and Larus teach the method of Claim 17, but do not teach that the value annotated to the edge of the control graph is either GUESS or UNKNOWN. Dean, however, does teach estimating path frequencies based on path profiling (Column 7, lines 1-4). Since an estimation can be seen as a guess, it is obvious that "GUESS" would be one of the labels for an edge of the program's control flow graph. Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to perform the method of Claim 17, where the value annotated to the edge of the control graph is GUESS, as taught by Dean, since this allows approximations in frequency counts.

10. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Buzbee et al. (U.S. Patent Number 5,815,720) in view of Heisch et al. (U.S. Patent Number 5,613,118) and further in view of Dean et al. (U.S. Patent Number 6,070,009) and Goebel (U.S. Patent Number 6,139,200).

In regard to Claim 20, Buzbee teaches: (1) accessing the first intermediate representation of source code with instrumented instructions (Column 2, lines 20-25); (2) Annotating intermediate code with data as shown in Figure 5, element 42; (3) Updating data using a propagation scheme. This is shown in Figure 5, elements 44-45, where a translator generates profile information based on annotations; (4) Optimizing intermediate code using the data. "Profile information 36 is used during a second compile to produce an optimized application 38. (Column 3, lines 55-56, figure 6); (5) repeating steps (3) and (4) at least once. The "process my

be repeated to generate additional profile information about the optimized object code to further optimize object code for the application." (Column 2, lines 16-18). Buzbee (U.S. Patent Number 5,815,720) does not specifically teach that the instrumented instructions are placed in the source code of the intermediate representation of the computer program. Heisch, however, does teach instrumenting source code with instructions for the purposes of data generation (Column 6, lines 14-16). Neither Buzbee nor Heisch specifically teaches that the feedback data annotated into the intermediate representation is estimated frequency data. Dean, however, does teach path profiling where execution frequencies of selected paths are estimated (Column 7, lines 1-4). Buzbee does teach performing multiple optimizations, but neither Buzbee, nor Heisch, nor Dean teach performing multiple updates and optimizations during the same compilation pass. Goebel, however, does teach performing multiple feedback data updates and optimizations in a single compiler pass (Figure 5, items 540 and 570 and Column 8, lines 30-35). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to access an instrumented source code, annotate it with data, and update the data and perform optimizations of the source code multiple times, as taught by Buzbee, where instrumentation instructions are placed in the source code, as taught by Heish, since this allows a programmer to adjust instrumentation at the more-understandable source level, and furthermore where the feedback data is estimated frequency data as taught by Dean, and the multiple updates and optimizations occur in one compiler pass, as taught by Goebel, since this allows for a fully optimized program on only one compilation.

Response to Arguments

11. Applicant's arguments with respect to claims 1, 6, 9, 14, and 20 have been considered but are moot in view of the new ground(s) of rejection.

In regard to other issues of Claim 1, the applicant states that the frequency at issue in Buzbee '720 is the frequency of the object code, while the invention deals with the frequency of the compiler's intermediate representation (Page 10, lines 23-25). However, Buzbee does teach keeping track of the frequency of source code statements (Column 7, lines 47-49), and not object code, as the applicant claims.

In regard to the Goebel reference, the applicant claims that he feedback data in Goebel measures register allocation, and the present invention is concerned with execution frequency of program code, thus the Goebel reference does not teach performing multiple feedback data updates (Page 11, lines 15-23). However, while the Goebel reference does not teach execution frequency feedback data, this is not the reason the reference was introduced. Goebel teaches performing multiple feedback data updates and optimization in a single compiler pass. The **type** of feedback data taught by the present invention has already been supported by Buzbee (U.S. Patent Number 6,275,981) in Column 1, lines 43-52 and Column 2, lines 6-20. It would be obvious to combine Buzbee and Goebel to teach "performing multiple feedback data updates and optimization in a single compiler pass" where the feedback data is frequency data, since frequency data is a common statistic collected about an executing program.

Finally, the applicant claims that Goebel never teaches updating feedback data, merely re-computing the data, which is different from the propagation scheme of Claim 1 (Page 12, lines 1-6). However, Buzbee '720 does teach updating frequency data by performing multiple

optimizations. On each optimization pass, a new frequency is computed, and an updated frequency is produced, which is more and more accurate, due to the multiple optimizations. Furthermore, re-computing feedback data can also be seen as updating the data, because each computation can produce more accurate results, as the program becomes better optimized.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kenneth A Gross whose telephone number is (703) 305-0542. The examiner can normally be reached on Mon-Fri 7:30-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tuan Q Dam can be reached on (703) 305-4552. The fax phone number for the organization where this application or proceeding is assigned is (703) 746-7239.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 305-3900.

KAG

TUAN DAM
SUPERVISORY PATENT EXAMINER